Extended Feature Set Profile Specification

Version 1.0

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Abstract

This specification defines Extended Feature Set (EFS) Profiles — sets of features to be used in latent fingerprint/palmprint searches of automated friction ridge identification systems (AFIS). The EFS Profiles are designed to be interoperable among AFIS systems from different vendors, to enable cross-jurisdictional searches that would not otherwise be practical. A small number of different EFS Profiles are defined to allow for tradeoffs between examiner time and search accuracy.

This is a supporting document for the American National Standard "Data Format for the Interchange of Fingerprint, Facial & Other Biometric Information" (ANSI/NIST-ITL 1-2011). The values defined here are used in ANSI/NIST field 9.303. The friction ridge features used are subsets of the EFS features defined in ANSI/NIST Type-9 friction ridge feature records.

EFS Profiles are designed so that they may be incorporated by reference into ANSI/NIST-based application profiles, such as the Latent Interoperability Transmission Specification (LITS). This decoupling of feature sets from transactions enables different transactions (or transactions from different organizations) to share a common feature set, aiding in interoperability.

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1.1   Purpose

The purpose of Extended Feature Set (EFS) Profiles is to define sets of features to be used in latent fingerprint/palmprint searches of automated friction ridge identification systems (AFIS). The EFS Profiles are designed to be interoperable among AFIS systems from different vendors, to enable cross-jurisdictional searches that would not otherwise be practical.

While the EFS Profile Specification provides details about which fields to mark for a given EFS Profile and when to mark them, the *Markup Instructions for Extended Friction Ridge Features* provides greater specificity. The *Markup Instructions* provides instructions specifically for the use of latent print examiners in marking extended friction ridge features, for the purpose of maximizing consistency among examiners.

1.2   Background

This is a supporting document for the American National Standard "Data Format for the Interchange of Fingerprint, Facial & Other Biometric Information" (ANSI/NIST-ITL 1-2011). This specification defines EFS Profiles for use in ANSI/NIST field 9.303.

EFS Profiles are defined groups of friction ridge (fingerprint/palmprint) features, primarily for use in vendor-neutral latent print searches of automated friction ridge identification systems (AFIS). The friction ridge features used are subsets of the EFS features defined in ANSI/NIST Type-9 friction ridge feature records.

The EFS Profiles defined here are incorporated by reference into the Latent Interoperability Transmission Specification (LITS), which is an application profile derived from ANSI/NIST-ITL 1-2011. The EFS Profiles are designed so that they may be incorporated by reference into other application profiles. This decoupling of feature sets from transactions enables different transactions (or transactions from different organizations) to share a common feature set, aiding in interoperability.

1.3   Conformance

The following terms are used in this document to indicate mandatory requirements, recommended options, or permissible actions:

- The terms "shall" and "shall not" indicate requirements strictly to be followed in order to conform to this standard and from which no deviation is permitted.

- The terms "should" and "should not" indicate a recommended or particularly suitable choice if presented with several possibilities, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form) a certain possibility or course of action is deprecated but not prohibited.

- The terms "may" and "need not" indicate a course of action permissible within the limits of this document.

To claim conformance to this specification, implementations shall meet image size requirements as defined in Section 3 – Image size requirements.

The *EFS Markup Instructions* specification provides further details on markup and is normative.

Conformance to this specification falls into the following classes:

- Basic Implementation

- Optional Implementation

BASIC IMPLEMENTATION

An ANSI/NIST-ITL transaction conforms to this specification if it satisfies the requirements for either *EFS Profile 0:*

Image-only Profile or *EFS Profile 2: Quick Minutiae Search*.

A system or software (such as AFIS or latent print workstation software) conforms to this specification if it produces[1] and/or consumes[2] ANSI/NIST-ITL transactions that satisfy the requirements for **both** *EFS Profile 0: Image-only Profile* and *EFS Profile 2: Quick Minutiae Search*.

OPTIONAL IMPLEMENTATION

An ANSI/NIST-ITL transaction conforms to this specification if it satisfies all the Basic Implementation requirements, as well as the requirements for any EFS Profile other than *EFS Profile 0: Image-only Profile* or *EFS Profile 2: Quick Minutiae Search*.

A system or software (such as AFIS or latent print workstation software) conforms to this specification if it satisfies all the Basic Implementation requirements, as well as if it either produces[1] or consumes[2] ANSI/NIST-ITL transactions that conform to this specification.

1.4 ANSI/NIST Extended Feature Set Profile field (9.303/FSP)

In ANSI/NIST-ITL 1-2011, Field 9.303: EFS feature set profile / FSP is defined in this way:

> *This optional numeric field is used to indicate an EFS Profile, which defines the specific set of EFS fields incorporated in a specific ANSI/NIST-ITL transaction. Profiles can be incorporated by reference into the definition of transactions: this decoupling of feature sets from transactions enables different transactions to share a common feature set, aiding in interoperability. If a given ANSI/NIST-ITL transaction is conformant with two or more profiles, the code for each profile is entered in a separate subfield. The valid values for this field are available in the EFS Profile Specification, which can be downloaded from http://www.nist.gov/itl/iad/ig/ansi_standard.cfm.*

Table 1 defines the valid codes for use in field 9.303.

Table 1: Extended Feature Set Profile Codes

Extended Feature Set Profile Code	Name	Image required
0[3]	Image-only profile	x
1	Minimal markup profile	x
2	Quick minutiae search profile	x
3	Detailed markup profile	x
4-9	*Reserved for future use*	
10	Skeleton profile	
11	Minutiae ridge count profile	
12-19	*Reserved for future use*	
20	Legacy IAFIS latent feature search profile	
21	Quick minutiae search profile without image	
22-29	*Reserved for future use*	
30	Search response profile with all and corresponding minutiae	
31	Search response profile without corresponding minutiae	
32-89	*Reserved for future use*	
90	Full annotation profile	x
91-99	*Reserved for future use*	

1.5 Correspondence with the FBI Electronic Biometric Transmission Specification (EBTS)

The U.S. Federal Bureau of Investigation (FBI) Electronic Biometric Transmission Specification (EBTS) version 9.3 corresponds directly to these EFS profiles:

- Latent Fingerprint Image Search (LFIS): EFS Profile 0
- Latent Fingerprint Feature Search (LFFS): EFS Profile 2;

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[1] *Produce == create, generate, or export.*

[2] *Consume == parse, ingest, or import.*

[3] *Note the code for EFS Profile 0 is never entered in field 9.303, since no ANSI/NIST Type-9 record shall be included in the transaction.*

	EFS Profiles 2+10 *(with skeleton)*
	EFS Profile 21 *(if image is not included)*
• Search Results – Latent (SRL):	EFS Profile 30
• Unsolved Biometric Match (ULM):	EFS Profile 31

2   EFS Profiles

Two EFS Profiles are designed to be common denominators and available across all interoperable systems: 0 (*Image-Only*) and 2 (*Quick Minutiae Search*). Additional optional EFS Profiles allow for tradeoffs between examiner markup time and search accuracy, a valuable consideration for systems that can make effective use of the additional features.

Each feature type is accompanied with a summary of when it is appropriate for an image to be marked, both to limit examiner markup, and to make explicit for the recipient of a transaction what the absence of a field means.

EFS Profile numbers not specifically listed here are reserved for future use.

2.1   EFS Profiles for fundamental latent AFIS transactions

The rationale for these EFS Profiles is to provide four levels of incremental tradeoffs between examiner time and matcher accuracy, based on common use of the features among AFIS vendors:

- EFS Profile 0: *Image-Only Profile* requires no examiner markup.
- EFS Profile 1: *Minimal Markup Profile* requires trivial examiner markup to improve the accuracy of image-only matching.
- EFS Profile 2: *Quick Minutiae Search Profile* includes the common denominator features used by the various AFIS vendors, and is compatible with FBI NGI, Prüm, and Interpol INT-I requirements.
- EFS Profile 3: *Detailed Markup Profile* includes features that can be used to increase search accuracy by some but not all of the AFIS vendors; skeletons and ridge counts, which require substantial examiner time, are addressed in the optional EFS Profiles (Section 2.2).

Each of the EFS Profiles 0 to 3 requires the image to be included in the transaction.

EFS PROFILE 0: IMAGE-ONLY PROFILE

Each image has no obscuring background or multiple impressions, and is upright (visually appears to be within approximately ±15° of tip up).

No ANSI/NIST Type-9 record shall be included in the transaction. Note the code for EFS Profile "0" is never entered in field 9.303, since there is no corresponding Type-9 record.

EFS PROFILE 1: MINIMAL MARKUP PROFILE

Each image is accompanied by a Type-9 record, which shall include the following fields, contingent on the "When to mark" restrictions:

Feature	Field	Mnemonic	When to mark
region of interest	9.300	ROI	always (may be identical to the image dimensions). The region of interest polygon (9.300e, ROP) is required if multiple impressions, complex background, or only a portion of the print is to be searched.
orientation	9.301	ORT	if the impression is upright, orientation does not need to be indicated; if the orientation cannot be determined, it shall be indicated as "unknown"; otherwise, the orientation shall be indicated.
finger/palm position(s)	9.302	FPP	if known
pattern class	9.307	PAT	if known (does not apply to palms, tips, or lower joints)
core(s)	9.320	COR	if present
delta(s)	9.321	DEL	if present

EFS PROFILE 2: QUICK MINUTIAE SEARCH PROFILE

Each image is accompanied by a Type-9 record, which in addition to the features specified in the *Minimal Markup profile*, shall include the following fields, contingent on the "When to mark" restrictions:

Feature	Field	Mnemonic	When to mark
(all features from Minimal Markup Profile)			
finger/palm position(s)	9.302	FPP	friction ridge position (FGP) – required, unknown finger/palm position may be indicated; finger segment (FSM) – if all or part of the medial or proximal finger segments are present (fingerprint only) off-center fingerprint (OCF) – if an extreme tip or extreme side (fingerprint only)
minutiae	9.331	MIN	always
evidence of fraud	9.354	EOF	if present

In the unusual case that there is evidence of fraud (evasion through altered prints, spoofing another subject's prints, or forged/fabricated latent prints), that shall be indicated. This information will be used in the administration of the AFIS database, and may or may not be not be used by the AFIS matcher itself.

EFS PROFILE 3: DETAILED MARKUP PROFILE

Each image is accompanied by a Type-9 record, which in addition to the features specified in the *Quick minutiae search profile*, and shall include the following fields, contingent on the "When to mark" restrictions:

Feature	Field	Mnemonic	When to mark
(all features from Minimal Markup profile and Quick Minutiae Search profile)			
ridge quality map	9.308	RQM	always
ridge flow map	9.310	RFM	always
center point of reference	9.323	CPR	if known (does not apply to palms)
distinctive features	9.324	DIS	if scars or other physical abnormalities (e.g. warts or dysplasia) are present; other distinctive features optional
dots	9.340	DOT	if present
incipient ridges	9.341	INR	if present

SPECIAL CASES

If the impression may be a possible lateral reversal (it is unclear if it may be flipped left-for-right, such as in some prints on transparent tape), then for AFIS searches two search transactions shall be created, one forward and one flipped, to avoid the complexity/potential confusion of comingling candidate matches for normal and flipped images in a single response. Therefore, the possible lateral reversal field (9.315) shall not be used when conducting AFIS searches, but may be used for annotating casework. **NOTE:** The EFS Profile Specification assumes that an AFIS system **will not** have to determine lateral reversals. While the EFS Profile specification provides the capability for marking a possible lateral reversal, it is an implementation detail for latent print workstation software to provide the latent examiner with the ability to generate two search transactions, either manually or automatically.

If the impression is inverted black-for-white so that ridges are shown in white and valleys are shown in black that should be indicated in the tonal reversal field (9.314).

In the unusual circumstance that the friction ridge impression is believed to have changed size or scale from potential comparisons, such as for deceased subjects with swollen or desiccated skin, or when comparing adult and juvenile prints, that should be indicated in the possible growth or shrinkage field (9.317).

2.2   EFS Profiles for maximized accuracy

These EFS Profiles include features that require substantial examiner time, but may optionally be used to maximize search accuracy (such as for critical cases or poor-quality latents).

These EFS Profiles are to be combined with the basic AFIS EFS Profiles 1..3; where these EFS Profiles are used, field 9.303 shall contain both the basic latent AFIS EFS Profile code (1..3) *and* the code for the optional EFS Profile. For

example, a skeleton in combination with the Minimal Markup Profile would include the codes for EFS Profiles 1 and 10 as separate subfields (occurrences) within field 9.303; a skeleton in combination with the *Detailed Markup Profile* would include the codes for EFS Profiles 3 and 10.

EFS PROFILE 10: SKELETON PROFILE

The skeleton (field 9.372) shall be included in addition to the fields in the specified EFS Profile 1 to 3.

Feature	Field	Mnemonic	When to mark
(all features from the specified profile 1 to 3)			
skeletonized image	9.372	SIM	always

When EFS profile 10 (*Skeleton profile*) is used in combination with EFS profile 3 (*Detailed markup profile*), the skeleton is marked as follows with respect to the ridge quality map (field 9.308):

- In all areas marked as "definitive minutiae" (green) or better, the skeleton must be complete and unbroken, and the skeleton's ridges only stop at ridge endings. Any areas of the print that cannot be represented in the skeleton shall be marked as "debatable minutiae" (yellow) or worse.
- In areas marked as "debatable minutiae" (yellow), the skeleton may be incomplete, and the skeleton's ridges may stop at locations that do not correspond to ridge endings.

When EFS profile 10 is used in combination with EFS profile 1 (*Minimal markup profile*) or 2 (*Quick minutiae search profile*), treatment of the skeleton is as if the entire region of interest had been marked using the ridge quality map value of "debatable minutiae" (yellow): the skeleton may be incomplete, and the skeleton's ridges may stop at locations that do not correspond to ridge endings.

EFS PROFILE 11: MINUTIAE RIDGE COUNT PROFILE

Minutiae ridge counts (field 9.333) shall be included in addition to the fields in the specified EFS Profile 2 (*Quick minutiae search profile*) or 3 (*Detailed markup profile*) — since ridge counts are dependent on minutiae, they would not apply to EFS Profiles 0 (*Image-only profile*) or 1 (*Minimal markup profile*). The minutiae ridge count algorithm shall be indicated in field 9.332.

Feature	Field	Mnemonic	When to mark
(all features from the specified profile 1 to 3)			
minutiae ridge count algorithm	9.332	MRA	always
minutiae ridge counts	9.333	MRC	always

2.3   Special-purpose and legacy profiles

These are solely included to accommodate existing legacy system interfaces, or special-purpose needs, and are not to be implemented unless they are specifically called for.

EFS PROFILE 20: LEGACY IAFIS LATENT FEATURE SEARCH PROFILE

This EFS Profile accommodates the fields used in the FBI EFTS 7.1 LFFS transaction definition, as used by IAFIS and implemented as an interface for some other systems. This EFS Profile (unlike the others) does not require the image to be present. This EFS Profile does not apply to palms. The Type-9 record shall include the following fields, contingent on the "When to mark" restrictions:

Feature	Field	Mnemonic	When to mark
region of interest	9.300	ROI	if multiple impressions, complex background, or only a portion of the print is to be searched
orientation	9.301	ORT	if known
finger/palm position(s)	9.302	FPP	if known
pattern class	9.307	PAT	if known (does not apply to palms, tips, or lower joints)
core(s)	9.320	COR	if present
delta(s)	9.321	DEL	if present
core-delta ridge counts	9.322	CDR	always
minutiae	9.331	MIN	always
minutiae ridge count algorithm	9.332	MRA	always (set to "EFTS7")
minutiae ridge counts	9.333	MRC	always

EFS PROFILE 21: QUICK MINUTIAE SEARCH PROFILE WITHOUT IMAGE

There are occasionally situations in which it is not possible to include the latent image in a search, due to bandwidth restrictions (possibly in emergency situations), or sensitivity of images. Use of this EFS Profile is not considered best practice with respect to accuracy, and shall be used only if specifically called for. This EFS Profile is identical to the Quick Minutiae Search Profile, but the image shall not be included in the transaction.

2.4   Search Response Profiles

These EFS Profiles define the use of type-9 fields if features are returned in association with candidate lists, such as in a search results transaction in response to a latent AFIS search. Most frequently the candidates are exemplars (rolled or plain impressions), but may be latents from a search of unsolved latent databases.

Note that this does not mandate that features necessarily be returned for search results transactions; it defines the contents when search results transactions do include such features.

EFS PROFILE 30: SEARCH RESPONSE PROFILE WITH ALL AND CORRESPONDING MINUTIAE

The search response returns the pattern class, finger/palm position and all minutiae for the candidate; in addition, the specific minutiae that correspond between the search print and the candidate are indicated in the corresponding points or features field. The Type-9 record shall include the following fields, contingent on the "When to mark" restrictions:

Feature	Field	Mnemonic	When to mark
region of interest	9.300	ROI	always
orientation	9.301	ORT	if known
finger/palm position(s)	9.302	FPP	always (may be "unknown")
pattern class	9.307	PAT	if known
core(s)	9.320	COR	if present
delta(s)	9.321	DEL	if present
minutiae	9.331	MIN	always
method of feature detection	9.350	MFD	recommended (vendor and version of algorithm)
corresponding points or features	9.361	CPF	if present
relative rotation of corresponding print	9.363	RRC	if known

EFS PROFILE 31: SEARCH RESPONSE PROFILE WITHOUT CORRESPONDING MINUTIAE

The search response returns the pattern class, finger/palm position and all minutiae for the candidate, but no corresponding points or features. The Type-9 record shall include the following fields, contingent on the "When to mark" restrictions:

Feature	Field	Mnemonic	When to mark
region of interest	9.300	ROI	Always
orientation	9.301	ORT	if known
finger/palm position(s)	9.302	FPP	always (may be "unknown")
pattern class	9.307	PAT	if known
core(s)	9.320	COR	if present
delta(s)	9.321	DEL	if present
minutiae	9.331	MIN	Always
method of feature detection	9.350	MFD	recommended (vendor and version of algorithm)

2.5   Examiner annotation profiles

These EFS Profiles are included for examiner annotation of analysis or comparison, rather than for AFIS searches.

EFS PROFILE 90: FULL ANNOTATION PROFILE

Each image is accompanied by a Type-9 record, which may optionally include any of the extended feature set fields, such as pores; creases; ridge edge features; latent substrate, matrix, or processing; or analysis assessment (value). This is a superset of the Quick Minutiae Search profile: at a minimum, the features specified in the Quick Minutiae Search profile shall be marked according to the rules in that profile.

3   Image size requirements

A system or software (such as AFIS or latent print workstation software) that conforms to this specification and produces[4] ANSI/NIST-ITL transactions shall not permit larger image sizes than specified.

A system or software (such as AFIS or latent print workstation software) that conforms to this specification and consumes[5] ANSI/NIST-ITL transactions may permit larger image sizes than specified.

For fingerprints or extreme tips:

- For EFS Profiles 1, 2, or 3, the maximum width or height of the region of interest shall not exceed 1.5" (38.1 mm); the image size may be larger than the region of interest.
- For EFS Profile 0 (which has no associated region of interest), the maximum width or height of the image shall not exceed 1.5" (38.1 mm).

For palmprints, lower joints, or full finger views, there is no maximum image or region of interest size beyond the ANSI/NIST limitations; however, best practices may choose to constrain the image or region of interest size.

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[4] *Produce == create, generate, or export.*
[5] *Consume == parse, ingest, or import.*